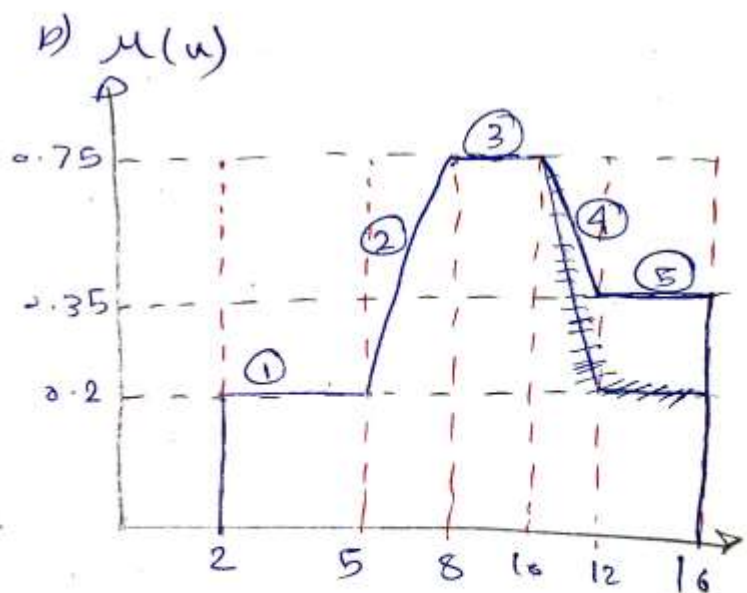
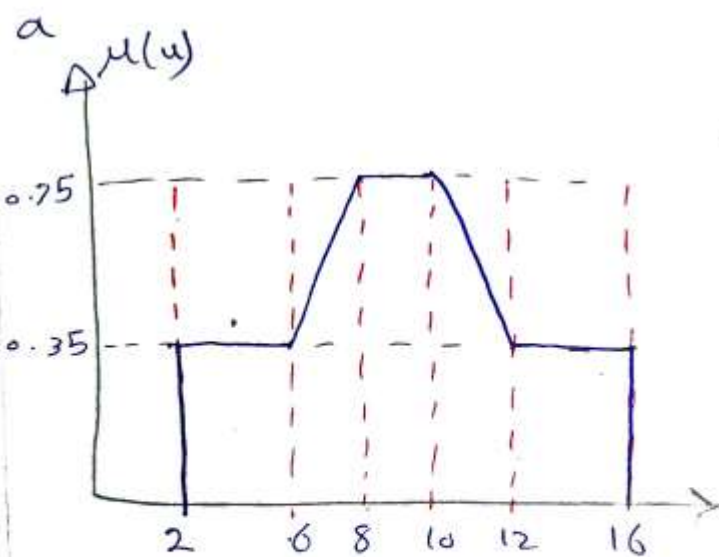


Sheet 4

Sec 5

1) Find the crisp out of the Fuzzy controller that has the following overall Fuzzy output ~~as~~ shown in following cases



overall Fuzzy o/p

دالة مركز

CoG

$$u^{crisp} = \frac{\int \mu(u) u \, du}{\int \mu(u) \, du}$$

دالة

weighted average

دالة مرجحة

$$u^{crisp} = \frac{\sum \mu(u_i) u_i}{\sum \mu(u_i)}$$

For a

$$\mu_{\text{crisp}} = \frac{0.75 * 9}{0.75} = 9$$

For b

$$\mu_{\text{crisp}} = \frac{\int \mu(u) u du}{\int \mu(u) du} = \frac{I_1}{I_2}$$

$$I_1 = \int_2^5 0.2 u du + \int_5^8 \left( \frac{0.55}{3} u - \frac{2.15}{3} \right) u du + \int_8^{10} 0.75 u du \\ + \int_{10}^{12} (-0.2 u + 2.75) u du + \int_{12}^{16} 0.35 u du$$

From 5  $\rightarrow$  8

$$\frac{\mu(u) - 0.2}{u - 5} = \frac{0.75 - 0.2}{8 - 5} \Rightarrow \frac{0.55 u}{3} - \frac{2.15}{3} = \mu(u)$$

From 10 to 12

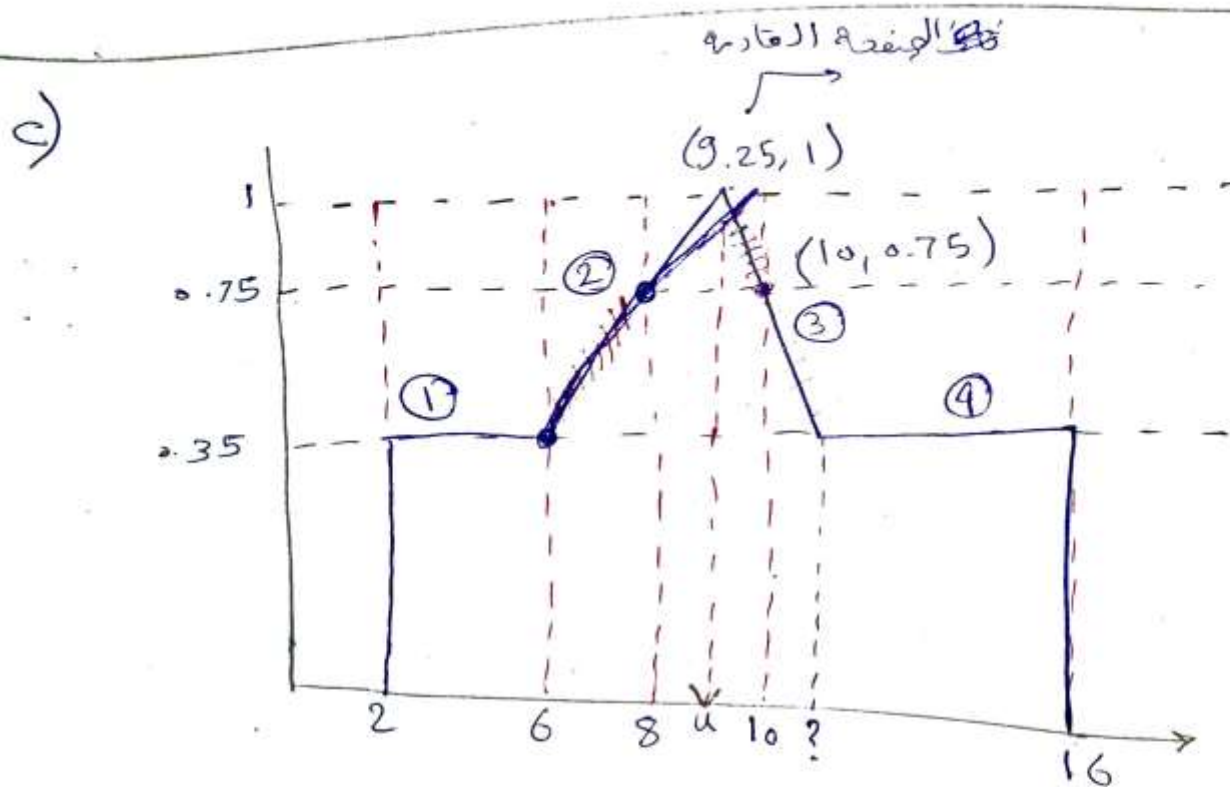
$$\frac{\mu(u) - 0.75}{u - 10} = \frac{-0.4}{2} \Rightarrow \mu(u) = -0.2 u + 2.75$$

(2)

$$I_2 = \int_2^5 0.2 du + \int_5^8 \left( \frac{0.55}{3}u - \frac{2.15}{3} \right) du + \int_8^{10} 0.75 du$$

$$+ \int_{10}^{12} (-0.2u + 2.75) du + \int_{12}^{16} 0.35 du = \checkmark$$

$$u^{\text{crisp}} : \frac{I_1}{I_2} = 12.3$$



منه نحتاج معادله الخط الذي عليه شرط بالاعتماد.

$$\frac{\mu(u) - 0.35}{u - 6} = 0.2$$

$$\mu(u) = 0.2u - 0.85$$

$$\text{Put } \mu(u) = 1 \rightarrow \text{to let } u$$

$$\therefore u = 9.25$$

From (9.25, 1) to (10, 0.75)

$$\frac{\mu(u) - 1}{u - 9.25} = \frac{-0.25}{0.75} = -\frac{1}{3}$$

$$\mu(u) = -\frac{1}{3}u + \frac{12.25}{3}$$

$$\text{Put } \mu(u) = 0.35 \Rightarrow u = 11.2$$

↳ not symmetric so we will use CoG.

$$u^{\text{crisp}} = \frac{\int \mu(u) u \, du}{\int \mu(u) \, du} = \frac{I_1}{I_2}$$

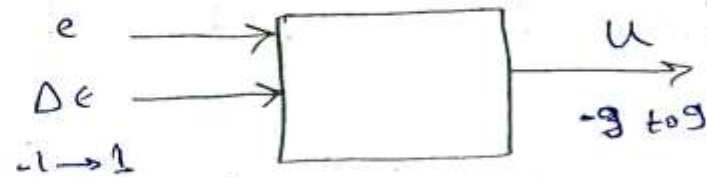
$$I_1 = \int_2^6 0.35u \, du + \int_5^8 (0.2u - 0.85)u \, du +$$

$$\int_{9.25}^{11.2} \left(-\frac{1}{3}u + \frac{12.25}{3}\right)u \, du + \int_{11.2}^{16} 0.35u \, du = \checkmark$$



\*

$-4 \rightarrow 4$

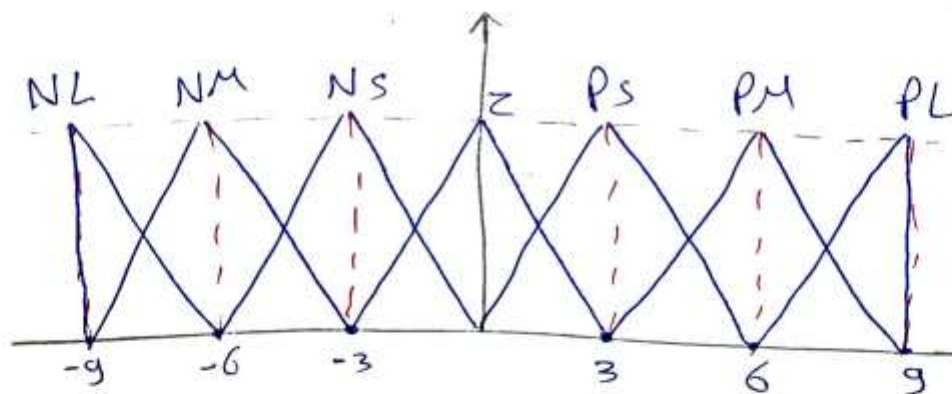
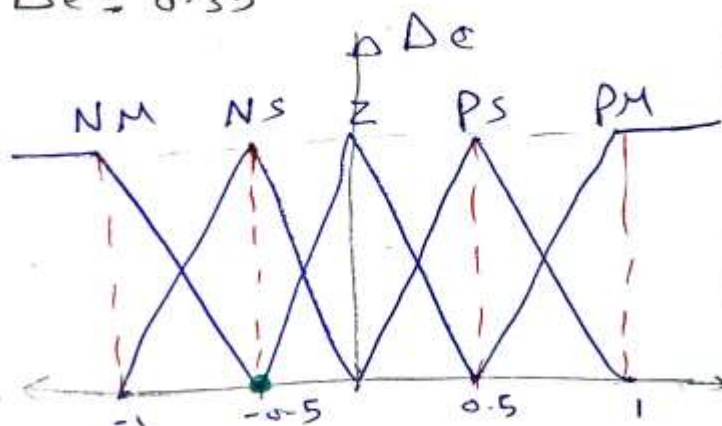
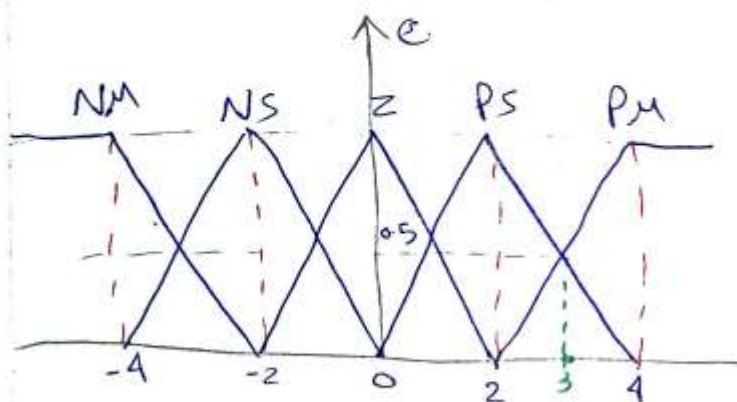


crisp  
u

①  $e = 3$  and  $\Delta e = -0.5$

②  $e = -2$  and  $\Delta e = -0.2$

③  $e = 2.6$  and  $\Delta e = 0.35$



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$\Delta e$ \ $e$	NM	NS	Z	PS	PM
NM	PL	PL	PM	PS	Z
NS	PL	PM	PS	Z	NS
Z	PM	PS	Z	NS	NM
PS	PS	Z	NS	NM	NL
PM	Z	NS	NM	NL	NL

← عكس الجميع الحبري  
 $NM + NM = NL \Rightarrow PL$

$e=3 \rightarrow \begin{cases} PS \text{ with } \mu_{PS}(e) = 0.5 \\ PM \text{ with } \mu_{PS}(e) = 0.5 \end{cases}$

$\Delta e = -0.5 \rightarrow NS \text{ with } \mu_{NS}(\Delta e) = 1$

## Fired rules

R1: if  $e$  is  $PS$  &  $\Delta e$  is  $NS$  then  $u$  is  $Z$

R2: if  $e$  is  $PM$  &  $\Delta e$  is  $NS$  then  $u$  is  $NS$

→ The degree of Premise

$$R_1: \mu_{p_1} = \min\{\mu_{PS}(e), \mu_{NS}(\Delta e)\}$$

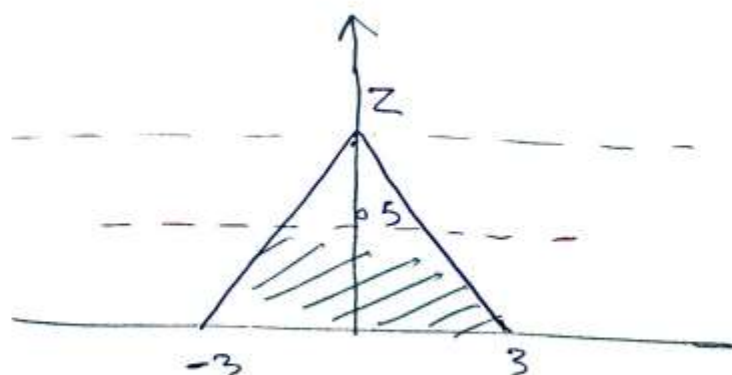
$$= \min\{0.5, 1\} = 0.5$$

$$R_2: \mu_{p_2} = \min\{\mu_{PM}(e), \mu_{NS}(\Delta e)\}$$

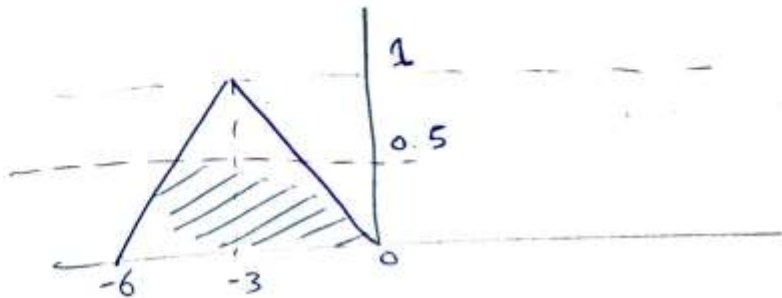
$$= \min\{0.5, 1\} = 0.5$$

The Fuzzy forms of a/p

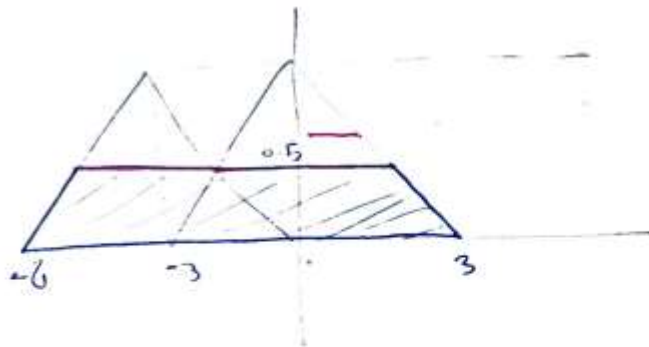
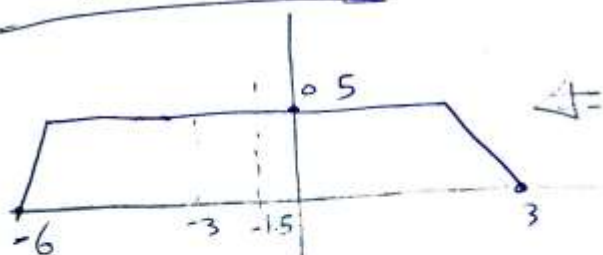
$$R_1 \Rightarrow \mu_Z(u) = \min\{\mu_{p_1}, \mu_Z(u)\} = \min\{0.5, \mu_Z(u)\}$$



$$R_2 \rightarrow \mu_{NS}(u) \min \left\{ \mu_{P_2}, \mu_{NS}(u) \right\}$$



## Aggre<sup>re</sup>gation



overall Puzzy o/p

$$u^{\text{crisp}} = -1.5$$

eb)

$$e=2 \rightarrow NS$$

at  $\mu(e) = 1$

$$\Delta e \rightleftharpoons NS \quad \mu(\Delta e)_{s, -0.4}$$
$$L \rightarrow Z \quad \mu(\Delta e)_s \approx 0.6$$

بہ باقی الخطباء زی رحمہ ا

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